

WHAT IS CLAIMED IS:

1. An apparatus for dispensing droplets of fluid comprising:  
a fluid chamber having an opening therein for droplet dispensing;  
5 a first actuator mechanically coupled to said fluid chamber and  
configured to alter the volume thereof;  
a second actuator mechanically coupled to said fluid chamber and  
configured to alter the volume thereof, wherein said second  
actuator is further away from said opening than said first actuator;  
10 and  
a driver connected to substantially simultaneously actuate said first and  
said second actuators so as to dispense fluid droplets from said  
fluid chamber.
2. The apparatus of Claim 1, wherein said driver is connected to actuate  
15 said second actuator prior to actuating said first actuator.
3. The apparatus of Claim 1, wherein said first and said second actuators  
are more than approximately 10 mm away from said opening.
4. An apparatus for dispensing droplets of fluid comprising:  
a fluid chamber having an opening therein for droplet dispensing;  
20 a first actuator mechanically coupled to said fluid chamber and  
configured to alter the volume thereof;  
a second actuator mechanically coupled to said fluid chamber and  
configured to alter the volume thereof; and  
a driver connected to actuate said first and said second actuators so as to  
25 alter the volume of said fluid chamber, whereby a fluid response  
produced by said first actuator is damped by said second actuator.
5. The apparatus of Claim 4, wherein said driver is connected to actuate  
said first and said second actuators substantially simultaneously.
6. The apparatus of Claim 4, wherein said driver is connected to actuate  
30 said second actuator prior to actuating said first actuator.

7. The apparatus of Claim 4, wherein said first and said second actuators comprise piezoelectric material.

8. A piezoelectric fluid aspiration and dispensing device comprising a capillary having an opening in one end for aspirating and dispensing fluid, wherein said capillary is at least partially surrounded by a plurality of cylindrical piezoelectric actuators positioned behind said opening, wherein said plurality of cylindrical piezoelectric actuators are coupled to drive circuitry for actuation; and wherein said glass capillary is unrestricted behind said piezoelectric actuators so as to allow aspirated particulate material to flow away from said opening during a reverse flush cycle.

9. The dispensing device of Claim 8, wherein a first cylindrical piezoelectric actuator extends from approximately 16 mm behind said opening to approximately 29 mm behind said opening.

10. The dispensing device of Claim 9, wherein a second cylindrical piezoelectric actuator extends from approximately 32 mm behind said opening to approximately 45 mm behind said opening.

11. A method of depositing a volume of fluid comprising compressing a cylindrical capillary with a plurality of cylindrical actuators.

12. The method of Claim 11, wherein said compressing is performed substantially simultaneously.

13. The method of Claim 11, wherein a first one of said plurality of cylindrical actuators is actuated before a second one of said plurality of cylindrical actuators.

14. A method of droplet deposition comprising:  
altering the volume of a fluid chamber with a first actuator;  
damping a fluid response to said volume alteration with a second actuator.

15. The method of Claim 14, wherein said altering comprises compressing said fluid chamber.

16. The method of Claim 15, wherein said damping comprises compressing said fluid chamber.

17. The method of Claim 15, wherein said compressing is performed substantially simultaneously.

18. The method of Claim 17, wherein said compressing is performed sequentially.

5 19. The method of Claim 14, wherein said altering comprises electrically actuating a first piece of piezoelectric material, and wherein said damping comprises electrically actuating a second piece of piezoelectric material.

20. The method of Claim 19, wherein said actuating a first piece of piezoelectric material and actuating a second piece of piezoelectric material are performed substantially simultaneously.

21. A droplet dispensing apparatus comprising:  
a fluid chamber;  
a first means for altering the volume of said fluid chamber; and  
a second means for altering the volume of said fluid chamber, wherein  
15 said second means additionally comprises means for damping a fluid response to said first means.

22. The droplet dispenser of Claim 21, wherein said first and said second volume altering means comprise piezoelectric material.

23. The droplet dispensing apparatus of Claim 22, additionally comprising a driver circuit connected in parallel to said first and said second piezoelectric means.

20 24. A method of making a droplet deposition device comprising:  
positioning a first actuator proximate to an ejection nozzle of a fluid chamber;  
positioning a second actuator farther from said ejection nozzle than said  
25 first actuator; and  
connecting both of said actuators to a driver.

25. The method of Claim 24, wherein said positioning comprises substantially surrounding a glass capillary with cylindrical piezoelectric actuators.

26. The method of Claim 25, wherein said connecting comprises connecting  
30 said piezoelectric actuators in parallel to a voltage source.

27. A droplet dispensing apparatus comprising:

a fluid chamber;  
a first piezoelectric means for altering the volume of said fluid chamber;  
and  
a second piezoelectric means for damping a fluid response to said  
altering.

5

Patented May 19, 1964